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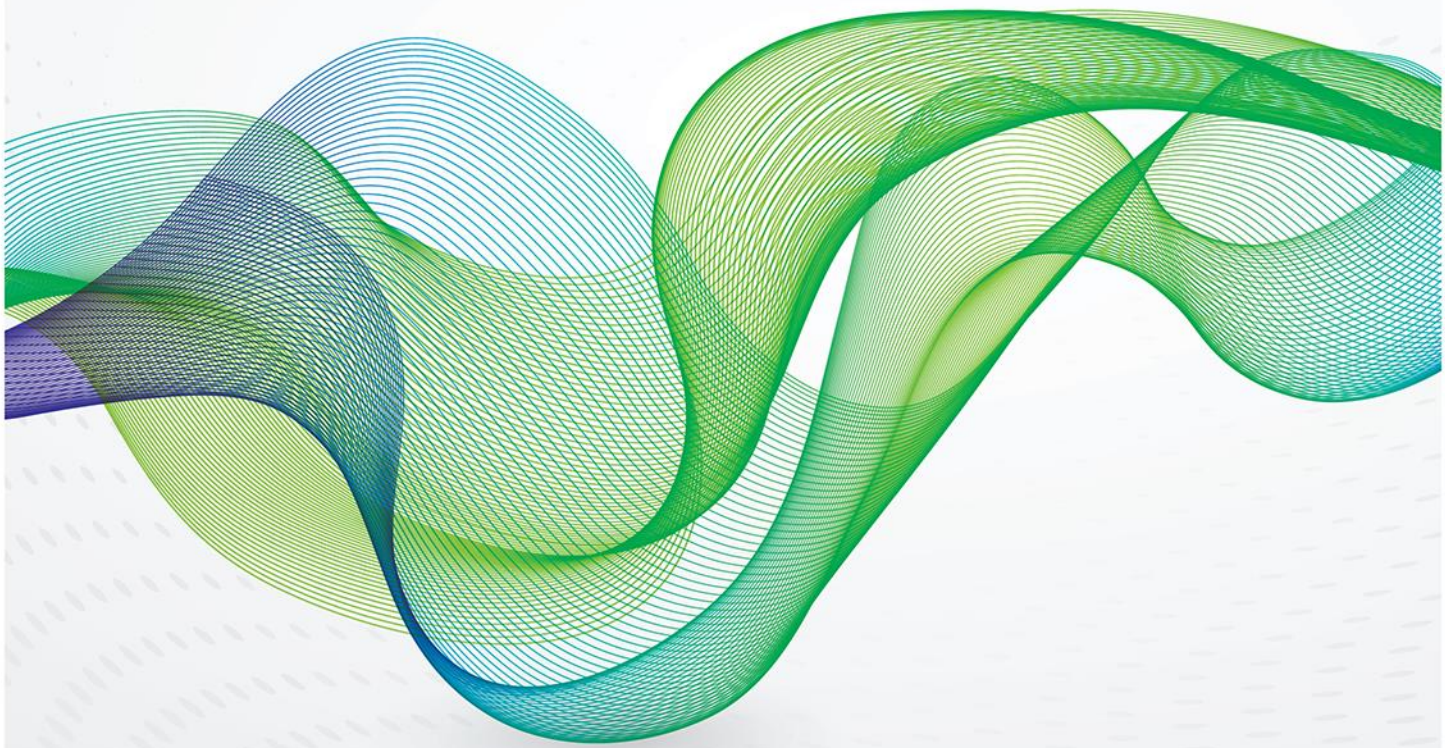
Ukrainian Gas Transit: Still Vital for Russian Gas Supplies to Europe as Other Routes Reach Full Capacity



OXFORD ENERGY COMMENT

Jack Sharples

Introduction

In recent years, natural gas demand in Europe has reversed the decline witnessed between 2010 and 2014. During the same period, 'domestic' gas production in Europe has continued to decline (most notably in the Netherlands), leading to increased European gas import demand. This has particularly benefitted Gazprom, which has experienced significant success in growing the volumes of its exports to the European market to record levels in 2016 and 2017. This success continued into Q1 2018, with Gazprom announcing a 6.6% increase in gas exports to Europe versus Q1 2017, and a new monthly record, with the 19.6 bcm exported in March 2018 surpassing the previous record of 19.1 bcm exported to Europe in January 2017.[1]

In a recent OIES paper, Henderson and Sharples identified infrastructure as a limiting factor in the further growth in Russian gas exports to Europe, noting that the overall high annual level of utilisation means that "in key peak demand winter months…the system is practically full".[2] Gazprom's reports of record monthly gas exports to Europe prompted this author to consider the extent to which the pipeline system that brings Russian gas to Europe really was 'full' on peak days in Q1 2018, and whether there is now a capacity constraint.

The conclusions drawn from this analysis have relevance not only to Gazprom's ongoing pipeline projects, Nord Stream 2 and Turkish Stream, but also to the question of gas transit via Ukraine after the end of 2019, when Gazprom's existing gas transit contract with Naftogaz Ukrainy expires.

The volume of Gazprom's gas exports to Europe

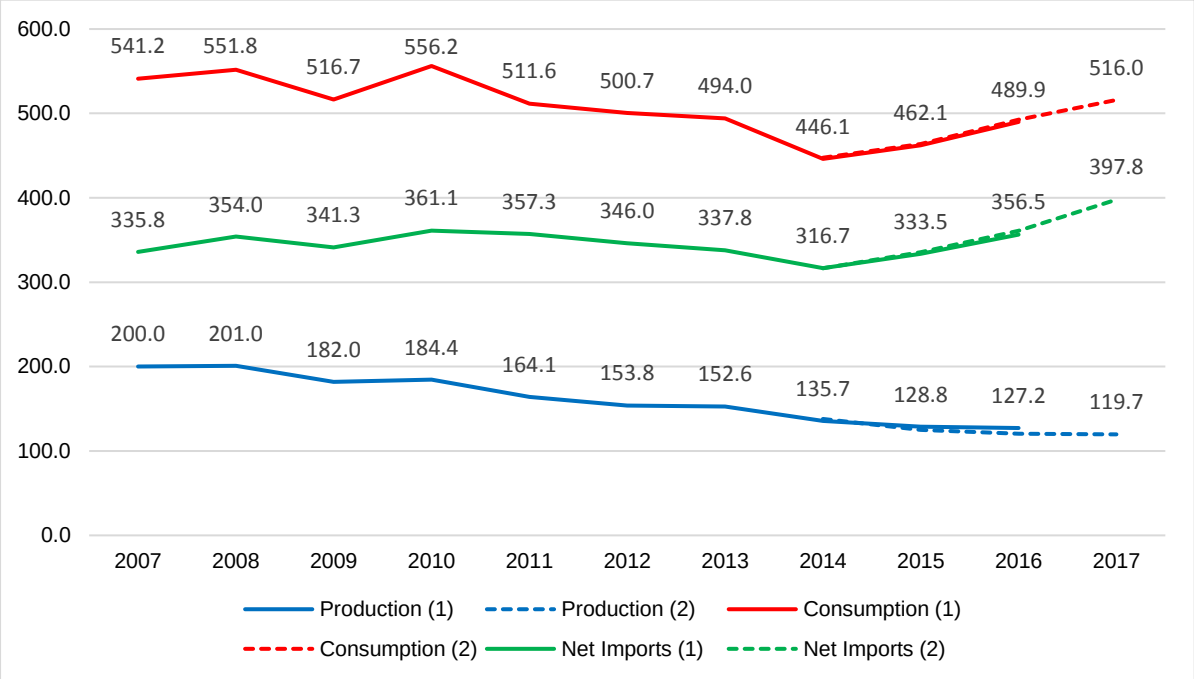
After several years of decline, total European gas demand rose between 2015 and 2017. This recent recovery in European gas demand has taken place during a period of continued decline in European gas production, leading to a growth in European gas imports. This has opened a window of opportunity for Gazprom to increase its gas exports to Europe, as illustrated by Fig.1 and Fig.2 (below). Furthermore, higher overall annual import volumes raise the 'baseline' from which volumes peak in the winter months, thus further raising the daily volumes that flow through Gazprom's export pipelines on days of peak demand.

As Europe was gripped by cold weather in late February and early March 2018 (dubbed the 'Beast from the East' by the UK media[3]), Gazprom reported record daily export volumes. According to Gazprom Export, Gazprom's previous record for daily gas flows to Europe was 640 million cubic metres, set on the 19th of December 2017. That record was reportedly broken on the 21st of February, and gas flows increased every day for ten consecutive days, culminating in a new record of 713.4 mmcm on the 2nd of March 2018.[4]

These figures from Gazprom are quoted in standard Russian cubic metres, and when they are converted to Standard European cubic metres (see Appendix 2), they equate to a December 2017 record of 582.38 mmcm/d and a new record of 649.17 mmcm/d in March 2018. The aim of this paper is to explain how those volumes were delivered to Europe, and the extent to which the physical pipeline capacity for delivering Russian gas to Europe was fully utilised.

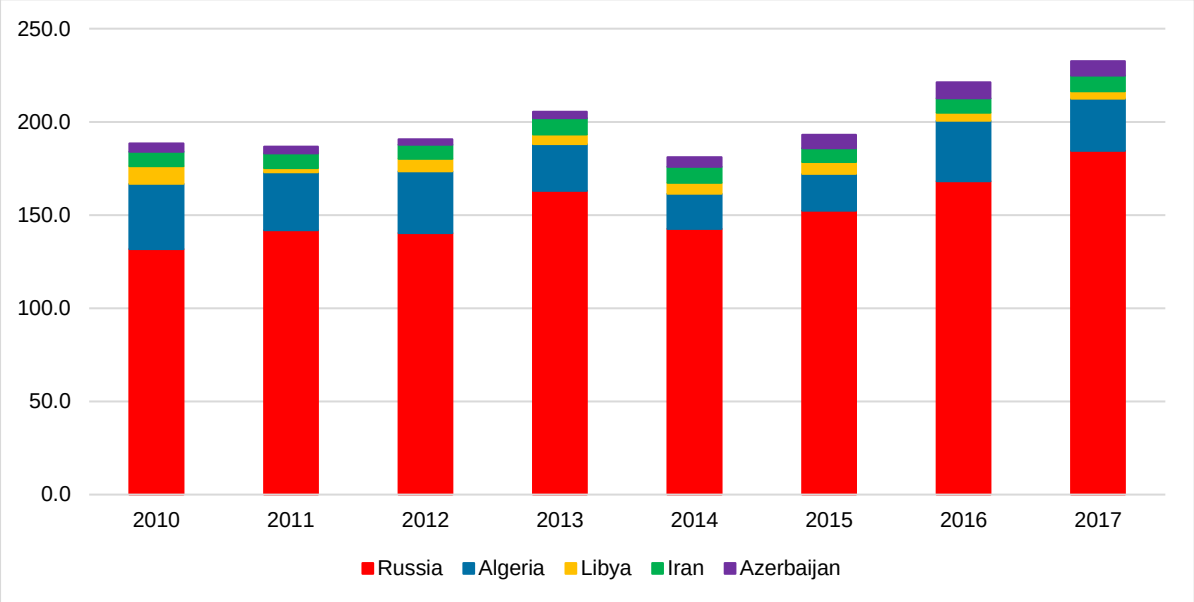
[1] Gazprom Export, 2018. Gazprom Sets Another Record in Monthly Gas Supplies. *Press release*, 3 April. http://www.gazpromexport.ru/en/presscenter/news/2126/. Sourced on 09 May 2018.
[2] Henderson, J., and Sharples, J., 2018. *Gazprom in Europe – two "Anni Mirabiles", but can it continue?* Oxford Energy Insight 29. https://www.oxfordenergy.org/publications/gazprom-europe-two-anni-mirabiles-can-continue/. Sourced on 09 May 2018. See page 16.
[3] Guardian, 1 March 2018.' Beast from the East meets storm Emma, causing UK's worst weather in years'.
[4] Gazprom Export, 2018. *Russian Gas Export Sets New Records*. Press release, 5 March. http://www.gazpromexport.ru/en/presscenter/news/2109/. Sourced on 09 May 2018.

Figure 1: EU-28 plus Turkey natural gas production, consumption, and net imports



Source: Eurostat[5] [6]

Figure 2: European gas pipeline imports by source (bcm)



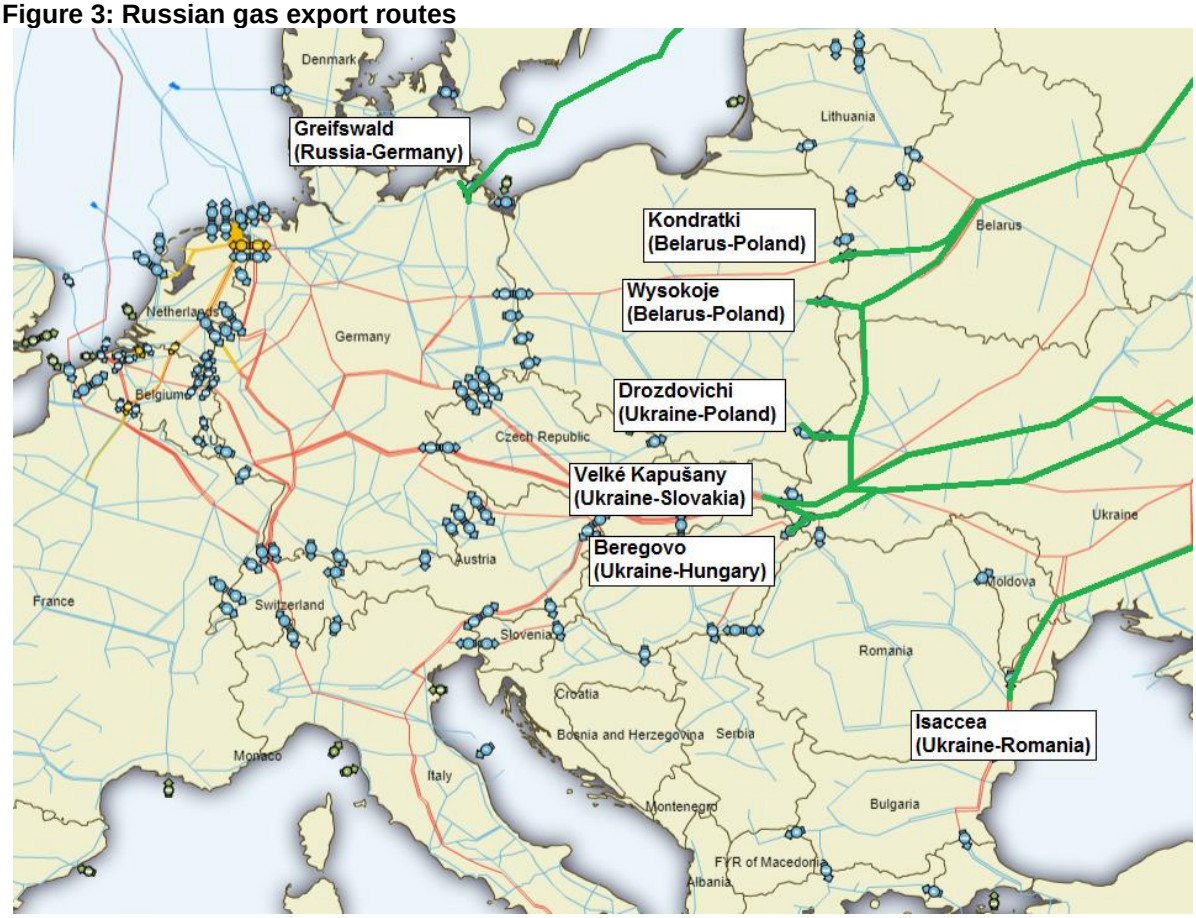
Source: IEA[7]

[5] Eurostat, 2018. *Supply of gas – monthly data [nrg_103m]* and *Supply, transformation and consumption of gas - annual data [nrg_103a]*. http://ec.europa.eu/eurostat/data/database. Sourced on 09 May 2018. Monthly data (2014-2018) and annual data (2007-2016) for Primary Production, Imports, Exports, Gross Inland Consumption, Stock Changes, and Stock Levels

[6] Data sourced in TJ and converted to bcm using a factor of 40 MJ/m3. Data (1) is annual data and data (2) is monthly.

[7] This graph illustrates pipeline imports by OECD Europe i.e. including Turkey

Figure 3: Russian gas export routes



Source: Map from IEA adapted by the author[8]

Gazprom's gas export routes to Europe

Gazprom has access to multiple pipeline export routes for the delivery of its gas to the European market, as illustrated in Fig.3 (above). Greifswald is the point at which the Nord Stream pipeline enters the German gas transmission system. Kondratki is the point at which the Yamal-Europe pipeline crosses from Belarus into Poland. Wysokoje is the point at which the Soviet-era gas transmission system delivers gas from Belarus to Poland. Drozdovichi, Velké Kapušany, and Beregovo are the points at which gas passes from Ukraine into Poland, Slovakia, and Hungary, respectively. Finally, Isaccea is the border point between Ukraine and Romania. In addition, the Blue Stream pipeline delivers Russian gas direct to Turkey, and Gazprom is able to make direct deliveries to Finland, Estonia, Latvia, and Lithuania.

In order to measure daily flows of Russian gas into the European market, this paper uses data from the Transparency Platform published by the European Network of System Operators for Gas (ENTSOG), which provides data on physical flows of gas through cross-border metering stations. In addition to providing data on daily flows through each of these metering stations, the ENTSOG Transparency Platform provides information on the daily capacities of these cross-border connections (in Gigawatt hours per day, or GWh/d) and the gross calorific value (GCV) of the gas that is passing through those interconnections. By combining the data on gas flows and capacities in GWh/d and the GCV, it is possible to calculate the flows in million cubic metres per day (mmcm/d).

As a platform that collates data from individual transmission system operators (TSOs) that operate the pipelines, ENTSOG is the only collective source of daily data for these gas flows. However, the International Energy Agency (IEA) does provide monthly gas flow data with a two-month time lag, and

[8] IEA, 2018. *Gas trade flow in Europe*. https://www.iea.org/gtf/. Sourced on 09 May 2018.

data on the cross-border capacities, in mmcm/d. This IEA data has been used to corroborate the data from ENTSOG on pipeline capacities. It should also be noted that the pipeline capacity data from ENTSOG refers to 'Firm Booked plus Available Capacity', which is used as a proxy for the physical capacity of these pipelines. Finally, ENTSOG does not provide data for pipelines outside the EU, meaning that data for the Blue Stream pipeline from Russia to Turkey is not included in this analysis. However, data for Blue Stream is available from the IEA, as illustrated in the table below.

Figure 4: Capacities of cross-border pipeline connections

	Capacity (mmcm/d)		*Capacity (bcm/y)*	
Cross-Border Connection	*ENTSOG*	*IEA*	*ENTSOG*	*IEA*
Greifswald (Russia-Germany)	155.4	160.1	56.7	58.4
Kondratki (Belarus-Poland)	97.4	97.5	35.6	35.6
Wysokoje (Belarus-Poland)	15.9	15.8	5.8	5.8
Drozdovichi (Ukraine-Poland)	12.6	16.5	4.6	6.0
Velké Kapušany (Ukraine-Slovakia)	189.0	197.5	69.0	72.1
Beregovo (Ukraine-Hungary)	56.4	56.4	20.6	19.2
Isaccea (Ukraine-Romania)	70.9	96.0	25.9	35.0
Sub-Total	597.6	639.8	217.7	233.5
Blue Stream (Russia-Turkey)	-	43.8	-	16.0
Total (IEA data only)	-	683.6	-	249.5

Source: Data from ENTSOG[9] and the IEA[10]

The daily capacities for ENTSOG are the mathematical average of the daily capacities provided by the ENTSOG Transparency Platform, adjusted in line with the conversion from 'normal' cubic metres (Nm3) to 'standard' cubic metres (Sm3), as explained in Appendix 2. The IEA capacities are fixed. What is immediately clear is that Gazprom's stated new daily record of exports to Europe (including Turkey) of 649.17 mmcm/d (as measured in standard European cubic metres) equates to 95.0% of Gazprom's total export pipeline (IEA-rated) capacity (including Blue Stream).

To compare Gazprom's reported sales to the capacities available at the seven interconnection points noted above, it is necessary to discount direct deliveries to Turkey via the Blue Stream pipeline and direct deliveries to Finland and the Baltic states. At the time of writing, the most recent IEA data show that the Blue Stream pipeline was utilised at an average rate of 102.4% of its capacity from July 2017 to January 2018. If it is assumed that Blue Stream operated at a similar rate in February and March, this equates to average daily flows of 44.9 mmcm/d. When these flows are subtracted from Gazprom's stated record flow of 649.17 mmcm/d, the result is deliveries of 604.27 mmcm/d. Furthermore, direct flows to Finland averaged 10.3 mmcm/d in Q1 2018. These flows reached an average of 13.6 mmcm/d during the peak period from the 21st of February to the 2nd of March 2018, and 12.9 mmcm/d on Gazprom's record-breaking day of the 2nd of March. Finally, flows to Estonia, Latvia, and Lithuania (along with flows to Ukraine, Belarus, and Moldova) are not included in Gazprom's definition of 'Europe', and are instead included in Gazprom's exports to the former Soviet Union (FSU). Therefore, flows to Estonia, Latvia, and Lithuania are excluded from this analysis.

Altogether, this means that on its record-breaking day, Gazprom delivered 591.37 mmcm to Europe via the seven points highlighted in Fig.3. These interconnection points have a combined daily capacity of between 597.6 mmcm/d (ENTSOG) and 639.8 mmcm/d (IEA). This suggests that, on the 2nd of March 2018, the pipeline infrastructure used to deliver Russian gas to the continental European market was operating at between 92.4% and 99.0% of its capacity. In other words, the system was virtually 'full'.

[9] ENTSOG, 2018. *Transparency Platform*. https://transparency.entsog.eu/. Sourced on 09 May 2018.
[10] IEA, 2018. *Gas trade flow in Europe*. https://www.iea.org/gtf/. Sourced on 09 May 2018.

For Q1 as a whole, Gazprom Export reports sales to Europe of 54.4 bcm.[11] When converted from Russian standard units, this equates to 49.50 bcm, or an average of 550.0 mmcm/d. Again, once exports to Turkey via Blue Stream (an assumed 44.9 mmcm/d for 90 days) and Finland (10.3 mmcm/d for 90 days) have been subtracted, Gazprom's Q1 2018 sales to Europe via the seven points equate to an average daily flow of 494.8 mmcm/d. This is equivalent to 82.3% of the total capacity quoted by ENTSOG (597.6 mmcm/d), and 77.3% of that suggested by the IEA (639.8 mmcm/d).

Utilisation of the key export routes

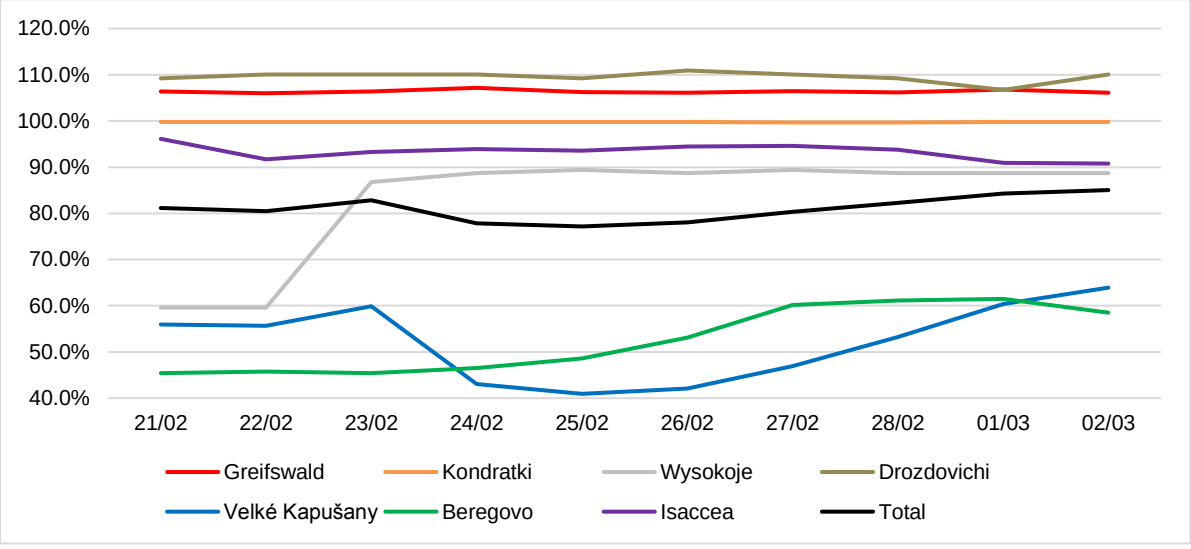
This high level of utilisation of the pipeline export system as a whole during Q1 2018, and especially during Gazprom's record-breaking period from the 21st of February to the 2nd of March, necessitates an examination of flows through each of the seven delivery points, to establish precisely how much spare capacity remains during periods of peak gas flows.

The data for the daily gas flows for each of the seven interconnection points was sourced from ENTSOG, and is presented in Appendix 1 of this paper. These daily flows have been applied to the cross-border capacities given by ENTSOG, to calculate the share of these capacities that was utilised on each of the ten days in February-March 2018 that Gazprom broke its own sales records.

This task is complicated by the fact that the data on actual, physical flows from ENTSOG do not match the figures given by Gazprom. Even when adjusted from Russian to European standard cubic metres, and taking into account the lower calorific value of Russian gas, Gazprom's record daily delivery to Europe of 591.37 mmcm on the 2nd of March 2018 is substantially higher than the 507.3 mmcm that ENTSOG report as having physically flowed through the seven interconnection points on that day[12]. This may be partly explained by the fact that, while the ENTSOG data measures *physical gas flows* through metering stations located at border points, the Gazprom data relates to Gazprom's *sales* to the European market, including gas withdrawn from storage facilities in Europe.

In order to ensure that the data for flows and capacities are compared on a 'like for like' basis, physical flow data and capacities from ENTSOG are used to calculate capacity utilisation rates during the ten-day peak in Gazprom's gas sales to Europe, and form the basis of the conclusions that follow.

Figure 5: Share of capacity utilised at cross-border connection points, 21/02/2018 to 02/03/2018

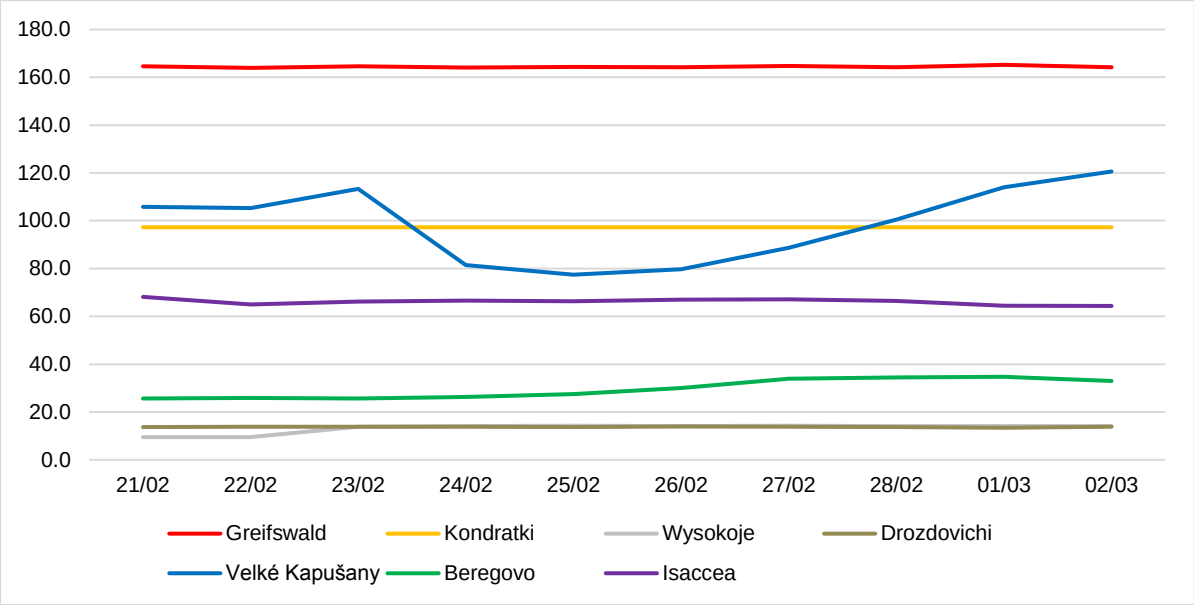


Source: Data on physical flows and capacities (firm booked plus available) from ENTSOG[13]

[11] Gazprom Export, 2018. Gazprom Sets Another Record in Monthly Gas Supplies. *Press release*, 3 April. http://www.gazpromexport.ru/en/presscenter/news/2126/. Sourced on 09 May 2018.
[12] See Appendix 1, Fig.2 (physical flows and capacities in standard European cubic metres)
[13] ENTSOG, 2018. *Transparency Platform*. https://transparency.entsog.eu/. Sourced on 09 May 2018.

As the graphs above and below illustrate, the stated flows via Greifswald and Drozdovichi were above the nameplate capacities, while capacity utilisation at Kondratki and Isaccea remained consistently high (90-100%). By contrast, flows through the route with the largest capacity (Velké Kapušany) never exceeded two-thirds of that capacity, although they did rise substantially between the 26th of February and 2nd of March. Finally, capacity utilisation at Wysokoje rose to meet the need for increased flows, as did capacity utilisation at Beregovo. During the period from the 21st of February to the 2nd of March, total capacity utilisation at these seven points rose from 81% to 85%.

Figure 6: Physical gas flows at cross-border connection points, 21/02/2018 to 02/03/2018 (mmcm/d)



Source: Data on physical flows from ENTSOG

The most straightforward conclusion to be drawn first is that Gazprom prioritised flows through the capacity that it owns, namely, Nord Stream, Yamal-Europe, and Wysokoje (the latter through its Belarusian subsidiary, Gazprom Transgaz Belarus). These high rates of utilisation are unlikely to be reduced even upon the completion of Nord Stream 2.

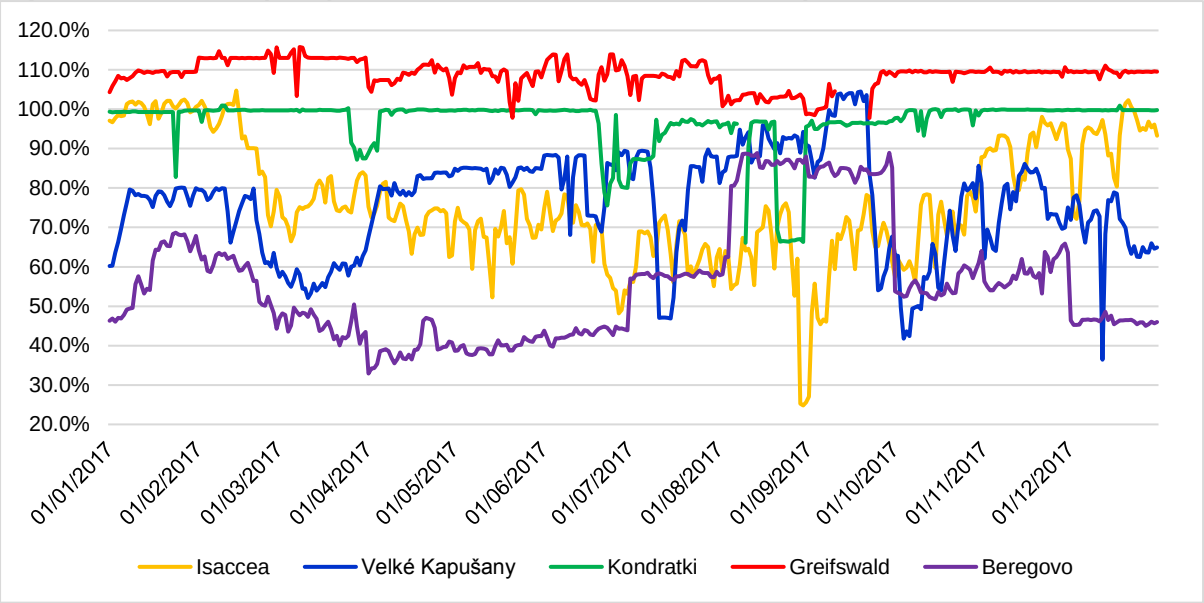
Secondly, the high rate of utilisation of Isaccea indicates high levels of demand for Russian gas in Turkey, which sits at the end of the Trans-Balkan Line. This line is likely to see substantial reduction in utilisation upon completion of the first line of Turkish Stream, as delivery routes shift and leave a residual volume destined for Bulgaria, Greece, and FYRM passing through Isaccea. However, given the lack of interconnections between SE Europe and the rest of the European market, spare capacity on the Trans-Balkan Line would do little to aid gas flows to other parts of Europe at times of peak demand.

Finally, the relatively low volume of flows via Velké Kapušany and Beregovo in relation to capacity means that Ukraine is the only transit route with spare capacity in times of peak winter demand. When expressed in standard cubic metres, the combined capacity of Velké Kapušany and Beregovo of between 245.4 mmcm/d (ENTSOG) and 253.9 mmcm/d (IEA) handled average daily flows of ranging from 131.4 mmcm/d on the 21st of February to 153.6 mmcm/d on the 2nd of March, with an average of 128.4 mmcm/d during the period between these two dates. This equates to utilisation ranging from 53.5% (21st February) to 62.6% (2nd March), with an average utilisation of 52.3%, when measured against the capacities stated by ENTSOG. Given that average daily gas flows through the four Ukrainian border points between the 21st of February and 2nd of March (208.4 mmcm/d in Sm3) accounted for 43.1% of total Russian gas flows to Europe[14] during this period, the role of Ukrainian

[14] Excluding Finland, the Baltic states, and direct flows to Turkey via Blue Stream

transit (and its associated spare capacity) during times of peak European gas import demand remains significant.

Figure 7: Share of capacity utilised at cross-border connection points, 01/01/2017 to 31/12/2017



Source: Data on physical flows and capacities (firm booked plus available) from ENTSOG

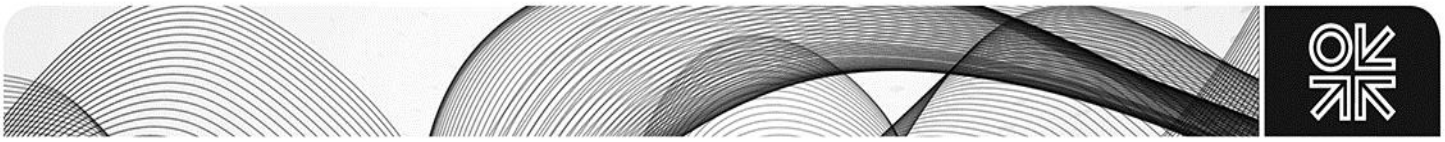
Although the relatively low utilisation of Velké Kapušany at a time of peak European gas import demand may appear counterintuitive, it can be explained by the examination of daily gas flows throughout the calendar year 2017. Here it is worth noting that flows via Greifswald were above 97% of capacity on all but 11 days in 2017, while flows via Kondratki were above 95% of capacity on all but 22 days, with daily average utilisation figures for 2017 of 108.9% and 96.8% respectively. In other words, these pipelines were fully utilised throughout the year.

At Isaccea, the flows were more strongly seasonal, with utilisation above 80% from the 1st of January to the 24th of February, and from the 30th of October to the 31st of December, with utilisation fluctuating mostly between 60% and 80% in the summer months. With Blue Stream fully loaded, Isaccea provided seasonal flexibility for Russian gas supplies to Turkey in line with seasonal Turkish demand.

By contrast, the data for gas flows via Velké Kapušany were counter-seasonal. Sustained capacity utilisation above 80% was seen in three periods: 18/04/2017-15/06/2018; 23/06/2018-08/07/2018; and 22/07/2018-21/09/2018. While Q1 and Q4 saw daily average flows of 124 and 125 mmcm/d, Q2 and Q3 saw daily average flows of 148 and 153 mmcm/d. Indeed, the 45 days from the 8th of August to the 21st of September saw an average utilisation rate of 94.5%, peaking at 101-105% (182-188 mmcm/d) from the 11th to the 21st of September – The same ten days that Nord Stream was taken offline for maintenance. This suggests that Velké Kapušany was used to refill storage facilities in Europe in the summer and throughout the year as backup for other pipeline infrastructure, rather than as capacity to be 'ramped up' during the periods of peak winter demand. Flows via Beregovo also peaked in the period 05/08/2017-30/09/2017, at 80-90% utilisation compared to an annual average utilisation of 56%.

Conclusion

The rise in Gazprom's annual gas exports to Europe in 2016 and 2017 raised the average daily utilisation of Gazprom's export routes throughout the year. The colder-than-average weather in Europe in February and March 2018 increased European demand for Russian gas, which led to higher-than-average Russian gas flows to Europe, and Gazprom's record sales in late February and



early March.

Across the seven routes highlighted in this paper, the total utilisation rate rose from 81% to 85% between the 21st of February and the 2nd of March, averaging 80% in Q1 as a whole. Within Q1, the monthly utilisation rate grew from 75% in January to 78% in February, and 86.0% in March, suggesting that the system is approaching full utilisation during winter months, with only Velké Kapušany as significant spare capacity. Any further increase in Russian gas deliveries to Europe (north-western Europe in particular) in 2018/19 could see a greater number of days on which the system is full, should Europe experience another cold winter in the context of a continued decline in European gas production. If the rise in European import demand is substantial enough, this bottleneck could be sufficient to cause a 'shortage' of Russian gas relative to demand, and price surges on the European spot gas market.

In terms of daily flows through specific pipelines, Gazprom's preference for loading pipelines it owns is clear, and must be expected to apply to Nord Stream 2 and Turkish Stream, unless there is a specific agreement with the European Commission to allocate some continued gas transit to Ukraine, or unless customers demand that gas still transits Ukraine. Therefore, gas transit via Poland (through the Yamal-Europe pipeline) is likely to continue even after the launch of Nord Stream 2, while Ukraine, Romania, and Bulgaria will see a substantial decline in gas transit via Isaccea after the launch of Turkish Stream.

Gas deliveries via Velké Kapušany are expected to fall substantially once Nord Stream 2 (55 bcm/y) and the proposed EUGAL pipeline (45.1 bcm/y) are launched.[15,16] If EUGAL had been available and fully utilised as a replacement for Velké Kapušany in 2017, gas deliveries via Velké Kapušany would have totalled around 7 bcm (down from 50 bcm), with 5.3 bcm of that concentrated in Q2 and Q3. This calculation is based on daily flows via Velké Kapušany compared to the daily capacity of EUGAL.

With ENTSOG data showing that Velké Kapušany was used at a daily average of 76% of its capacity throughout 2017, and Isaccea reporting an almost identical figure (while Nord Stream and Yamal-Europe were essentially full), gas transit via Ukraine will continue to be necessary in substantial volumes throughout the year (both 'peak' and 'off-peak') until Nord Steam 2 and Turkish Stream are launched. Thereafter, daily flows at 2017 levels would result in annual transit volumes of around 7 bcm via Velké Kapušany, 11 bcm via Beregovo, 4 bcm via Isaccea, and 4 bcm via Drozdovichi, totalling around 26 bcm of annual gas transit via Ukraine, compared to actual transit of 84.3 bcm via these routes in 2017.

Therefore, the continuation of gas transit via Ukraine in volumes greater than the 26 bcm/y suggested above will depend on the European Commission and European gas importers, and their insistence that gas transit via Ukraine continues. Otherwise, gas transit via Ukraine will be reduced to delivering limited volumes for European storage re-fills in the 'off-peak' summer months, and acting as a provider of 'peak flexibility' in the winter months, when daily demand rises above the daily capacities of other routes.

This prospect will undoubtedly complicate any negotiations between Gazprom and its Ukrainian counterparty over a new contract to govern the transit of Russian gas via Ukraine, once the existing contract expires at the end of December 2019. While Gazprom may be willing to commit to only limited annual transit volumes, the Ukrainian counterparty may question the commercial viability of maintaining a large gas transmission system with multiple exit points for the delivery of relatively small annual volumes, unless transit fees per cubic metre delivered were to increase significantly.

[15] EUGAL, 2018. *EUGAL: For a secure supply of natural gas in Europe*. https://www.eugal.de/en/eugal-pipeline/. Sourced on 09 May 2018.

[16] Taken together, Nord Stream 2, EUGAL, and the expansion of the West-East capacity of the Czech transmission system could enable the delivery of Russian gas to the Central European Gas Hub at Baumgarten without transit via Ukraine

Appendix 1: Capacity utilisation of seven key Russian gas export routes

Figure A1: Data from ENTSOG, measured in Normal cubic metres (Nm3)

Border Point	***Physical Flow (mmcm/d) – ENTSOG (Nm3)***										
	21/02	*22/02*	*23/02*	*24/02*	*25/02*	*26/02*	*27/02*	*28/02*	*01/03*	*02/03*	*Average*
Greifswald	156.0	155.4	156.0	155.5	155.8	155.6	156.1	155.7	156.6	155.6	155.8
Kondratki	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2
Wysokoje	9.0	9.0	13.1	13.4	13.5	13.4	13.5	13.4	13.4	13.4	12.5
Drozdovichi	13.0	13.1	13.1	13.1	13.0	13.2	13.1	13.0	12.7	13.1	13.0
Velké Kapušany	100.3	99.8	107.4	77.2	73.4	75.5	84.1	95.2	108.1	114.3	93.5
Beregovo	24.3	24.5	24.3	24.9	26.0	28.4	32.2	32.7	32.9	31.3	28.2
Isaccea	64.6	61.6	62.7	63.1	62.9	63.5	63.6	63.0	61.1	61.0	62.7
Total	459.4	455.6	468.8	439.4	436.8	441.8	454.8	465.2	477.0	480.9	458.0
Border Point	***Daily Capacity (mmcm/d) – ENTSOG (Nm3)***										
	21/02	*22/02*	*23/02*	*24/02*	*25/02*	*26/02*	*27/02*	*28/02*	*01/03*	*02/03*	*Average*
Greifswald	146.6	146.6	146.6	145.1	146.6	146.6	146.6	146.6	146.6	146.6	146.5
Kondratki	92.4	92.4	92.4	92.4	92.4	92.4	92.5	92.5	92.4	92.4	92.4
Wysokoje	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1
Drozdovichi	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
Velké Kapušany	179.3	179.3	179.3	179.3	179.3	179.3	179.2	178.8	179.0	178.8	179.2
Beregovo	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5
Isaccea	67.2	67.2	67.2	67.2	67.2	67.2	67.2	67.2	67.2	67.2	67.2
Total	566.0	566.0	566.0	564.5	566.0	566.0	566.0	565.6	565.7	565.5	565.7
Border Point	***Share of Capacity Utilised (%) – ENTSOG***										
	21/02	*22/02*	*23/02*	*24/02*	*25/02*	*26/02*	*27/02*	*28/02*	*01/03*	*02/03*	*Average*
Greifswald	106.4%	106.0%	106.4%	107.2%	106.3%	106.1%	106.5%	106.2%	106.8%	106.1%	106.4%
Kondratki	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%	99.7%	99.7%	99.8%	99.8%	99.8%
Wysokoje	59.6%	59.6%	86.8%	88.7%	89.4%	88.7%	89.4%	88.7%	88.7%	88.7%	82.8%
Drozdovichi	109.2%	110.1%	110.1%	110.1%	109.2%	110.9%	110.1%	109.2%	106.7%	110.1%	109.6%
Velké Kapušany	55.9%	55.7%	59.9%	43.1%	40.9%	42.1%	46.9%	53.2%	60.4%	63.9%	52.2%
Beregovo	45.4%	45.8%	45.4%	46.5%	48.6%	53.1%	60.2%	61.1%	61.5%	58.5%	52.6%
Isaccea	96.1%	91.7%	93.3%	93.9%	93.6%	94.5%	94.6%	93.8%	90.9%	90.8%	93.3%
Total	81.2%	80.5%	82.8%	77.8%	77.2%	78.1%	80.4%	82.2%	84.3%	85.0%	81.0%

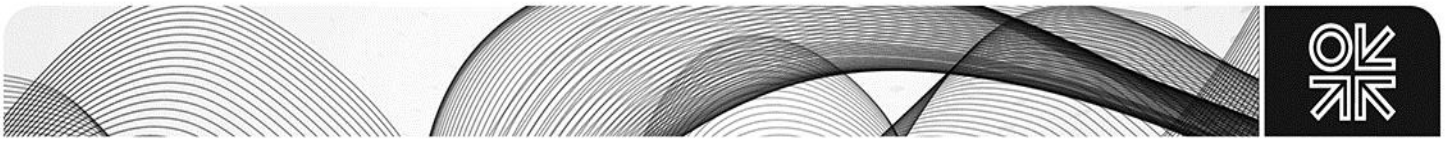


Figure A2: Data from ENTSOG, converted to Standard cubic metres (Sm3)

Border Point	***Physical Flow (mmcm/d) – ENTSOG (Sm3)***										
	21/02	*22/02*	*23/02*	*24/02*	*25/02*	*26/02*	*27/02*	*28/02*	*01/03*	*02/03*	*Average*
Greifswald	164.6	163.9	164.6	164.1	164.4	164.2	164.7	164.3	165.2	164.2	164.4
Kondratki	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3
Wysokoje	9.5	9.5	13.8	14.1	14.2	14.1	14.2	14.1	14.1	14.1	13.2
Drozdovichi	13.7	13.8	13.8	13.8	13.7	13.9	13.8	13.7	13.4	13.8	13.8
Velké Kapušany	105.8	105.3	113.3	81.4	77.4	79.7	88.7	100.4	114.0	120.6	98.7
Beregovo	25.6	25.8	25.6	26.3	27.4	30.0	34.0	34.5	34.7	33.0	29.7
Isaccea	68.2	65.0	66.1	66.6	66.4	67.0	67.1	66.5	64.5	64.4	66.2
Total	484.7	480.7	494.6	463.6	460.8	466.1	479.8	490.8	503.2	507.3	483.2
Border Point	***Daily Capacity (mmcm/d) – ENTSOG (Sm3)***										
	21/02	*22/02*	*23/02*	*24/02*	*25/02*	*26/02*	*27/02*	*28/02*	*01/03*	*02/03*	*Average*
Greifswald	154.7	154.7	154.7	153.1	154.7	154.7	154.7	154.7	154.7	154.7	154.5
Kondratki	97.5	97.5	97.5	97.5	97.5	97.5	97.6	97.6	97.5	97.5	97.5
Wysokoje	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9
Drozdovichi	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Velké Kapušany	189.2	189.2	189.2	189.2	189.2	189.2	189.1	188.6	188.8	188.6	189.0
Beregovo	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4
Isaccea	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9
Total	597.1	597.1	597.1	595.5	597.1	597.1	597.1	596.7	596.8	596.6	596.8
Border Point	***Share of Capacity Utilised (%) – ENTSOG***										
	21/02	*22/02*	*23/02*	*24/02*	*25/02*	*26/02*	*27/02*	*28/02*	*01/03*	*02/03*	*Average*
Greifswald	106.4%	106.0%	106.4%	107.2%	106.3%	106.1%	106.5%	106.2%	106.8%	106.1%	106.4%
Kondratki	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%	99.7%	99.7%	99.8%	99.8%	99.8%
Wysokoje	59.6%	59.6%	86.8%	88.7%	89.4%	88.7%	89.4%	88.7%	88.7%	88.7%	82.8%
Drozdovichi	109.2%	110.1%	110.1%	110.1%	109.2%	110.9%	110.1%	109.2%	106.7%	110.1%	109.6%
Velké Kapušany	55.9%	55.7%	59.9%	43.1%	40.9%	42.1%	46.9%	53.2%	60.4%	63.9%	52.2%
Beregovo	45.4%	45.8%	45.4%	46.5%	48.6%	53.1%	60.2%	61.1%	61.5%	58.5%	52.6%
Isaccea	96.1%	91.7%	93.3%	93.9%	93.6%	94.5%	94.6%	93.8%	90.9%	90.8%	93.3%
Total	81.2%	80.5%	82.8%	77.8%	77.2%	78.1%	80.4%	82.2%	84.3%	85.0%	81.0%

Appendix 2: Data issues

Converting Gazprom's data to standard European cubic metres

Data from ENTSOG is expressed in Normal Cubic Metres, while data from Eurostat, the IEA, and BP is expressed in Standard Cubic Metres, and data from Gazprom is expressed in Russian Standard Cubic Metres. To make the data used throughout this report comparable, two steps have been taken:

1. The data from ENTSOG has been converted from Normal Cubic Metres to Standard Cubic Metres. This has been achieved by multiplying each cubic metres by a factor of 1.055.
2. The data from Gazprom has been converted from Russian Standard Cubic Metres (measured at 20°C) to European Standard Cubic Metres (measured at 15°C):
   a. To account for the temperature change, every cubic metre is multiplied by a factor of 0.983.
   b. To account for the lower calorific value (37.0284 MJ/m3 versus the European standard of 40 MJ/m3), each cubic metre is multiplied by a factor of 0.92571 (that is: 37.0284/40 = 0.92571).
   c. Taken together, these two steps imply a conversion factor of 0.909, or a reduction of 9.0997%

This conversion brings Gazprom's stated exports to Europe of 179.3 bcm in 2016 and 194.4 bcm in 2017 down to 163.16 bcm in 2016 and 176.90 bcm in 2017. For comparison, Russian pipeline gas exports to Europe are reported at 166.1 bcm by BP and 170.6 bcm by the IEA.[17] [18] For the same year, OPEC report total Russian gas exports (pipeline and LNG) of 210.0 bcm[19], compared with BP (204.8 bcm), and the IEA (214.2 bcm).

Reconciling data from different sources

The greatest difficulty in analysing the flows of Russian gas to Europe is reconciling the different volumes reported by different sources. This paper is based on data from ENTSOG, but draws on data from Gazprom, the IEA, and Argus for triangulation. When comparing data from these sources, it becomes clear that the estimates for Gazprom's exports to Europe via the seven delivery points (excluding Finland and Blue Stream to Turkey) are rather similar when Gazprom and Argus are used as sources, and the Gazprom data is converted to standard European cubic metres: 15.4-15.8 bcm in January, 15.6-15.8 bcm in February, and around 17.8 bcm in March, giving a Q1 total of 48.8-49.5 bcm. The data from ENTSOG (when adjusted from normal to standard cubic metres) is also similar to the data from the IEA for January (13.1-13.8 bcm) and February (12.3-13.0 bcm).

However, there is a substantial difference between the Gazprom/Argus data on the one hand, and the ENTSOG/IEA data on the other. In January, the difference was approximately 2 bcm, and in February the difference was approximately 3 bcm. The key to reconciling this data may lie in the information contained in the Argus data: While the ENTSOG and IEA data measures physical gas flows through metering stations located at border points, the Gazprom and Argus data relates to Gazprom's *sales* to the European market, including gas withdrawn from storage facilities in Europe. However, the Argus data for combined gas flows via Nord Stream, Yamal-Europe, and Turkey are similar to the Argus data for Gazprom's sales to Europe when estimates for direct exports to Finland and Turkey are removed.

Therefore, at present, it appears to be impossible to reconcile the data from Gazprom/Argus and ENTSOG/IEA. However, the comparison of 'like for like' data in terms of gas flows and capacities from the same source (in this case, ENTSOG) remains valid, as do the conclusions drawn regarding levels of capacity utilisation.

[17] The figure from the IEA refers to 'Europe' as EU-28 plus Bosnia & Herzegovina, Croatia, and Serbia, but minus Estonia, Latvia, and Lithuania – This is directly comparable with Gazprom's own definition of 'Europe', which is broader than OECD Europe but excludes the three former Soviet Baltic states.

[18] BP *Statistical Review of World Energy 2017* (page 34) and IEA *Natural Gas Information 2017* (page II.43 and II.45)

[19] OPEC, 2017. *Statistical Bulletin 2017*. (page 126)